**Directional Drilling Calculations**

**Directional Survey Calculations**

The following are the two most commonly used methods to calculate directional surveys :

1. Angie Averaging Method

2. Radius of Curvature Method

Where, MD = course length between surveys in measured depth (ft)  
 Il,I2 = inclination (angle) at upper and lower surveys, degrees  
 A1,A2 = direction at upper and lower surveys

Sample Case : Use the Angle Averaging Method and Radius of Curvature  
 Method to calculate the following surveys :

|  |  |  |
| --- | --- | --- |
|  | **Survey 1** | **Survey 2** |
| Depth (ft) | 7482 | 7782 |
| Inclination (degrees) | 4 | 8 |
| Azimuth (degrees) | 10 | 35 |

**Angle Averaging Method :**

**Radius of Curvature Method :**

**DEVIATION/DEPARTURE CALCULATION**

Deviation is defined as departure of the wellbore from the vertical, measured by the horizontal distance from the rotary table to the target. The amount of deviation is a function of the dril angle (inclination) and hole depth.

The following diagram illustrates how to determine the deviation/departure:

DATA :

A

AB = distance from the surface

B

location to the KOP

KOP

BC = distance from KOP to the true

vertical depth (TVD)

BD = distance from KOP to the bottom

of the hole (MD)

CD = deviation/departure-dparture of

the wellbore from the vertical

AC = true vertical depth

AD = measured depth

D

C

To calculate the deviation/departure (CD), ft :

*CD (ft) = sin I x BD*

Sample Case : Kick off point (KOP) is a distance 2000 ft from the surface.

MD is 8000 ft. Hole angle (inclination) is 20 degrees.

Therefore the distance from KOP to MD = 6000 ft (BD):

CD (ft) = sin 20 x 6000 ft

= 0.342 x 6000 ft

= 2052 ft

From this calculation, the measured depth (MD) is 2052 ft away from vertical.

**DOGLEG SEVERITY CALCULATION**

**Method 1**

Dogleg severity (DLS) is usually given in degrees/100 ft. The following formula provides dogleg severity in degrees/100 ft and is based on the Radius of Curvature Method :

*DLS = (cos-1 [(cos I1 x cos I2) + (sin I1 x sin I2) x cos (A2 – A1)]x*

For metric calculation, substitute x

Where, DLS = dogleg severity, degrees/100 ft  
 CL = course length, distance between survey points (ft)  
 I1, I2 = inclination (angle) at upper and lower surveys (ft)  
 Al, A2 = direction at upper and lower surveys, degrees  
 Azimuth = azimuth change between surveys, degrees

Sample Case :

|  |  |  |
| --- | --- | --- |
|  | **Survey 1** | **Survey 2** |
| Depth (ft) | 4231 | 4262 |
| Inclination (degrees) | 13.5 | 14.7 |
| Azimuth (degrees) | N 10 E | N 19 E |

DLS = (cos-1 [(cos 3.5xcos 14.7) + (sin 13.5xsin 14.7) x cos (19 -10)]x

= (cos-1 [(.9723699 X .9672677)+(.2334453 x .2537579 x .9876883)]) x

= (cos-1 [(.940542) + (.0585092)]) x

= 2.4960847 x

= 8.051886 degrees/100 ft

**Method 2**

This method of calculating dogleg severity is based on the tangential method :

Where, DLS = dogleg severity, degrees/100 ft

L = course length, ft  
 I1, I2 = inclination (angle) at upper and lower surveys, degrees  
 Al, A2 = direction at upper and lower surveys, degrees

Sample Case :

|  |  |  |
| --- | --- | --- |
|  | **Survey 1** | **Survey 2** |
| Depth (ft) | 4231 | 4262 |
| Inclination (degrees) | 13.5 | 14.7 |
| Azimuth (degrees) | N 10 E | N 19 E |

**AVAILABLE WEIGHT ON BIT IN DIRECTIONAL WELLS**

A directionally drilled well requires that a correction be made in total drill collar weight because only a portion of the total weight will be available to the bit :

*P = W x Cos I*

Where, P = partial weight available for bit  
 Cos = cosine  
 I = degrees inclination (angle)  
 W = total weight of collars

Sample Case : W = 45.000 lb  
 I = 25 degrees

P = 45,000 x cos 25

= 45,000 x 0.9063

= 40,784 lb

Thus, the available weight on bit is 40,784 lb.

**DETERMINING TRUE VERTICAL DEPTH**

The following is simple method of correcting for the TVD on directional wells. This calculation will give the approximate TVD interval corresponding to the measured interval and is generally accurate enough for any pressure calculations. At the next surey, The TVD should be corrected to corespond to the directional driller’s calculated true vertical depth :

*TVD2 = cos I x CL + TVD1*

Where, TVD2 = new true vertical depth (ft)

Cos = cosine

CL = course length – number of feet since last survey

TVD1 = last true vertical depth (ft)

Sample Case : TVD (last survey) = 8500 ft  
 Deviation angle = 40 degrees  
 Course length = 30 ft

Solution : TVD2 = cos 40 x 3o ft + 8500 ft

= 0.766 x 30 ft + 8500 ft

= 22.98 ft + 8500 ft

= 8522.98 ft